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A Biomimetic Approach as a Sustainably Architectural Design in Designing Resort Hotels: A Study Case in the Tourism Beach of Tanjung Karang, Regency of Donggala, Central Sulawesi, Indonesia

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Abstract The Province of Central Sulawesi has an interestingly attractive potency of tourism beaches for tourists, such as white-sand beach, sunset spots, tropical beach forest, and the beauty of an underwater landscape, mainly coral reefs located in Tanjung Karang, the Regency of Donggala. The typographic preservation of this tourism destination is mostly still well-maintained, but some abandoned areas are also found due to tourists' or inhabitants' exploitation. It can be seen from buildings' layout exceeding the beach border, garbage stacking in the coastal area up to the sea, careless clear-water consumption, and unmanaged and uncontrolled waste management system. Based on these circumstances, a strategy to maintain existing natural preservation is highly required by the utilization of environmentally friendly energy. The sustainable strategy integrates hotel resort areas with its surroundings, viewed from biomimetic architecture, and contains climate, biology, architecture, and technology, collectively. The research, then, discusses how to respond to the natural condition of Tanjung Karang beach, by considering its surroundings in terms of adaptation to nature and evolution [1], and also utilizes regional climate-supported energy, optimally, such as the solar energy and heat, wind, and surroundings-sourced water. Further, the adaptation of a coastal-traditional architecture was also performed by duplicating (mimetic), a transformation was relevantly conducted. In this research, a biomimetic approach was not comprehensively done, but it was limited to a simple simulation process, consisting of site management, site analysis via environment interaction, the concept of the hotel resorts design considering traditional principles such as building style, the mass form of buildings, and a schematic and simulated management of partly renewable energy.

Keywords Biomimetic Architecture, Resort-Hotels, Adaptation and Evolution, Partly Energy Management

1. Introduction

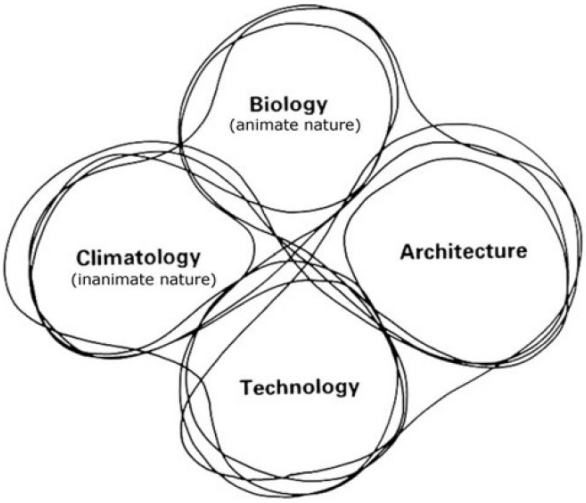
Humans affect ecosystems and evolutionary processes at great rates and in multiple ways [2]. Despite traditional approaches in the study of ecology where systems tended to be studied as unaffected and separate from human influence, it may be as [3] suggest, impossible to look at ecosystems as separate from human systems. Despite the fact that there may not be any ecosystems that are truly unaffected by humans, and that humans are inherently part

of the natural world, there are some obvious and essential differences in the way that non-human dominated and human-dominated systems work. The situation of tourism beach in Tanjung Karang is still natural, though some places or spots are not well-maintained due to the exploitation done by tourists, inhabitants, or investors. Likewise, the layouts of supporting buildings managed by residents or investors are established exceeding the beach border, garbage stacking in the coastal areas to sea, and the utilization of careless drinking water, and unmanaged and uncontrolled waste management system. These conditions, surely, will cause over-consumption of energy. If it is not accompanied by ideas to maintain natural preservation or an environmentally-friendly sustainable design system, the conservation of the surrounding will gradually be negatively affected. In addition, the over-consumption of energy, without understanding the importance of nature conservation, must become the main consideration. The focus is not only the attractive procurement of tourism facilities, but also harmony with the existence of surroundings. In doing so, sustainable facilities are required as a sampling model for other tourism objects in Tanjung Karang. Specifically, the supporting tourism facility as the model is resort hotels having architectural design employed biomimetic approach. This approach can be one of the solutions to natural destruction due to human exploitation. Therefore, the problem is how to design hotel resorts using the biomimetic approach in the Tourism Beach of Tanjung Karang.

1.1. Biomimetic Architecture

Biomimetic architecture, or biomimicry, is a contemporary philosophy of architecture in seeking the solution of naturally sustainable design (a design for a sustainable environment). It does not only mime the forms of the environment, but also understands rules and processes occurring in surroundings. Also, biomimetic architecture is a multidiscipline approach in sustainable design, so it follows a series of principles from varied architectural styles.

The biomimetic architecture, moreover, is underlined by technology (construction), climate (location) and biology, architecture (buildings from animals/plants) (Figure 1). Particularly, technology, in this research, focuses on natural construction. This kind of construction does not only mean things of unlimited diversity, but also have unique characteristics (ethnic). It means that such construction depicts the presence of clearly physical, biological, and technical processes in constructing an object. Additionally, if technology is a means of a natural object from humans, architecture knowledge, in general implementation, is generationally passed through by local tradition, usually called “vernacular”. While, traditional architecture refers to a term used in line with the bionic and biomimetic context, such as “evolution” and “adaptation”. One of the examples is discussed in the book entitled “Biomimetic architecture: Architecture of life and buildings. [1, 4]. The fundamental function of architecture is to provide shelter from changeable and often hostile natural environments. The built structure mediates between the environmental conditions outside and the interior climate, which is comforting for humans. Traditional architecture shows amazing adaptation to regional peculiarities of climate and resources. It is necessary for that different interactions (inputs and outputs) take place with the environment within the different building phases [4].



Amended by Gruber, 2011

Figure 1. Model of environmental processes, Olgyay 1963,

- Production: production and processing of materials, distribution, storage, transport.
- Construction: construction, building site.
- Operation: operation, maintenance, change, ecological measurements.
- Demolition and recycling: demolition, recycling, reuse, restoration of the site.
- Designing and building should be interpreted as management of material and energy more than it is now.

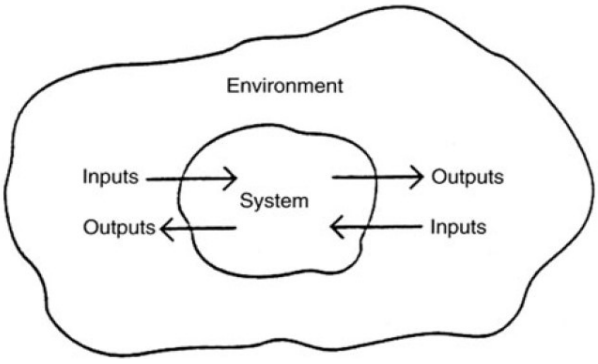


Figure 2. Model of a system and its relationships with the Environment, Yeang, 1995

1.2. Adaptation and Evolution of Kaili's Traditional Architecture in Central Sulawesi

The architecture of Central Sulawesi can be one of the examples of traditional architecture, adaptable to nature. In the context of biomimetic and natural structure, adaptation is used as a filter to observe the development or evolution from a building's typology and certain elements. Typically, the philosophy of traditional architecture is a mindset and traditional way of life, mutually respecting and maintaining a harmonious relationship with the environment. Kalili's traditional architecture, one of its buildings near the coastal area, is the traditional house of *Souraja*, or king's spiritual and religious house, combining three life elements: human, nature, and the creator. The basic philosophy of those forms of building starts from those three elements, established into three parts of the building, such as basement (human), middle (nature), and upper (the creator). In detail, three types of Kaili's house are differentiated by the middle structure of its building. The middle-class group is influenced by both cultural and external elements. Some terms used by the Kaili tribe, related to the building, are *Ni tari palemba*, *gandaria, bangku-bangku, kataba, makoto*, and so forth. It shows that the Kalili tribe is open-minded in understanding other cultural and natural elements [5]. The characteristic of Kalili's architecture is a terrace or known as *Gandaria* (Figure 3), a half-wall in the front porch aimed to enjoy the natural scenery as an interpretation of natural unification [5].

Figure 3. Façade of *Souraja* (*Gandaria*) (*Banua mbaso*)

2. Materials and Methods

This research is aimed to propose an architectural design development in the tourism sector. It discussed a sustainable relationship process between building and nature function in terms of hotel resorts. Later, the research employed a mixed-method (qualitative and quantitative) from the experiment result of energy-saving calculation in the buildings of hotel resorts. The sequential-mixed method collected and combined qualitative and quantitative data at once to provide a more comprehensive analysis of the research's issue. Further, in this design, the research also integrated information collected and interpreted the overall result, where the researcher gave one form of smaller data into larger data to analyze various types of research (qualitative discussed the process, and quantitative presented the result). Later, the transformative-mixed method [6] was a procedure where the researcher employed a theoretical lens as a comprehensive perspective in either qualitative or quantitative data. Hence, the lens provided a framework for the observed topic, data collecting technique, and the result of changes anticipated by the research. Additionally, the lens could be a data collecting method, involving a sequential or joint approach.

Design Method in the Biomimetic Architecture, in producing sustainable design, comprised of, as follows:

- Interaction between input and output, taking place in an environment on different phases of development, such as production, construction, operating, discharging, and recycling. Designing and constructing had to be interpreted as material and energy management. While, the ecological design required knowledge on building interaction with its environment of all site presences, recycling all inputs and outputs in the cycle. Thus, the interaction could measure concern on environmental changes with the existence of new structure and dynamical awareness of such interaction.
- Complexity. As analyzing an interaction, someone dealt with most issues, such as how to cure a damaged environment. In his book entitled "Skyscrapers green" [7] argued on the significant selection between issue and common system of public spaces, functioning as a diverse interaction complexity. One of them is shown in the following Table 1:

Table 1. Global resources and environmental pollution, and various estimations of industrial buildings [8]

Global Resources	
Resources	**Utilization in buildings**
Energy	50%
Water	42%
Mass material	50%
Loss of agricultural areas	48%
Coral reefs destruction	50% (indirect)
Global Pollution	
Pollution	**Related Buildings**
Air quality (urban)	24 %
Global warming	50 %
Drinking water pollution	40 %
Garbage piles	20 %
CFCs/HCFCs	50 %

Building consumption was related to resources and pollution. A building consumed half of the environmental resources, either houses or premises. The rest of half was consumed or formed for important purposes in required journey to human connection. The limitation of the human

system relied on resources shortage, but it was the waste product of environmental pollution, such as in the dense population of an urban area (London and Hongkong). Despite globally fatal impacts from pollution, the life cycle of human civilization was threatened by worse health issues caused by pollution. It was due to both architecture and industrial [8].

Therefore, principles and actions are significantly required to be a guidance in designing. Below, the methodological steps of interaction, complexity, and resources through buildings, open space, disposal, and supply are specifically described [8].

- Principles of adaptation to socio-traditional characteristics and environment to buildings are integrated into the ecosystem, depending on the Sun and wind, base-floor zone, and area of drinking water. In the open space, the actions include minimum sealing, some topographic changes, maintenance of the existing condition, and compact building. While, in supply and disposal, it comprises of near to house, service, culture, reducing personal traffic, relationship to public transportation, and low-energy emission relationship.
- Principle of energy-saving where the activities related to buildings, passive usage of the Sun's energy, heat conservation, heat recovery, winter gardens + solar utilization. In the open space, the actions are utilizing the effects of climate, vegetation, and water surface management. In addition, supply and disposal, the actions are closed-cycle made, if any, raw-materials waste, rainfall, wastewater, and waste's heat energy.
- Resources and material protection where the actions related to buildings, environmentally-friendly material usage, toxicity avoidance, a low-energy process, and production. While, in the open space, the actions are making green lane, parking integration, and green zone. Regarding supply and disposal, it consists of wasteful avoidance, electricity channels, and emission minimizing.
- Creation of internally and externally high-quality human environment, where the actions are the impact of micro-climate on building surface, façade and roof plants, sun protection, ergonomically working place, and interior design. In the open space, it consists of enriching the green zone by compatible trees with its location, making rest area, and environmental stimulation. While, disposal and supply, the actions are the utilization of water surface and organic garbage or compost for land recovery.

Certainly, all existing criteria cannot be done completely, and those depend on applicable conditions and situations for a method of sustainable design.

3. Results

Figure 4. Coastal Zone for Local Condition Analysis

The tourism beach of Tanjung Karang is located in the Regency of Donggala, Central Sulawesi, Indonesia (Figure 4). Geographically, it is in the Sub-District of Banawa, having a well-managed infrastructure to support government activities and public service.

Figure 5. Sites around the Tourism Beach of Tanjung Karang

Topographically, the site is hills (25%), where its altitude from the sea level is 5m (Figure 5). The existing rules necessarily considered in this site are the beach border as of 100m from the highest tidal and the borders of the research site, comprising of Makassar Strait (Northern), Palu Bay (Eastern), residential (Southern), and hills (Western).

3.1. Condition of Tourism Beach of Tanjung Karang

Based on the observation result, it can be described the initial condition existing in Tanjung Karang beach, as follows:

3.1.1. Accommodation Facility

Accommodations offered in the tourism object of Tanjung Karang beach were Toravega Cottage and Prince John Cottage. The residents, further, also provided some simple accommodation facilities, generally a wooden lodge with sago palm as its rooftop. Each accommodation had one bedroom, one open space as a terrace, and one bathroom. While other inns only had one bedroom and terrace with public bathroom service.

3.1.2. Vegetation Condition

In the first site, there were bushes, pandanus pasturage, grasses, coconut trees, shrimp pine trees, *Catapa* trees, *ru* trees, and Javanese wood trees. Also, these trees grew wildly and they needed to restructure by adding the type of plants in accordance with the beach environment. The restructuring, indeed, had to maintain the existing vegetation and did not obstruct the views and disturb resort function.

3.1.3. Site Circulation

The vehicle's circulation consisted of motorcycles or cars. The wide of the road was 5 meters and it had two-way circulation. The noise pollution was low due to the small number of vehicles. Later, a parking lot was not found, where, consequently, vehicles of visitors were placed carelessly. In the designing of site circulation, it should differentiate between the circulation of vehicles, pedestrians, and services to prevent cross-circulation.

3.1.4. Utility Network

The existing utilities in Tanjung Karang beach comprised of the electricity network, clean water resources originated from the unit of Local Water Entity (PDAM) of the Regency of Donggala. Further, the supply of clean water was stored in the water reservoir. From this reservoir, water was distributed to requiring units. However, the distribution was done individually, so the utilization could only be used by each person having a water reservoir. Regarding garbage, there were no garbage containers, provided by residents or the local government. In waste management, they were burned or dumped into the ground. It caused the coastal to be dirty, and the electricity network was directly supplied from State Power Plant.

3.1.5. Mangrove

The lack of mangroves surrounding the beach was found because many mangroves existed in Tanjung Karang beach, Donggala. The mangrove was the source of residents for living, such as fish. Previously, many residents in Tanjung Karang beach caught fish surrounding mangrove trees.

3.2. Site Analysis

Based on the comprehensive understanding of the characteristics of the site and its context, the planning of a sustainable site could protect and restore damaged natural resources and its culture and minimize destruction effects from development to the environment. The zoning was made as follows:

3.2.1. Zoning

Zone as depicted below (Figure 6) explains that semi-public was hotel resort and villa; the public was recreational area; and, private villa and floating villa as well as a service unit. Later, a construction site was made for each of usages, by the total area of the site as of 10,1 ha (ten-point one hectare). Then, the percentage of KDB and KLB was 70% of green area and 30% of constructed area. The construction planning of floating areas or accommodation in the sea was an attractive and varied combination between land and sea accommodation, located in the land.

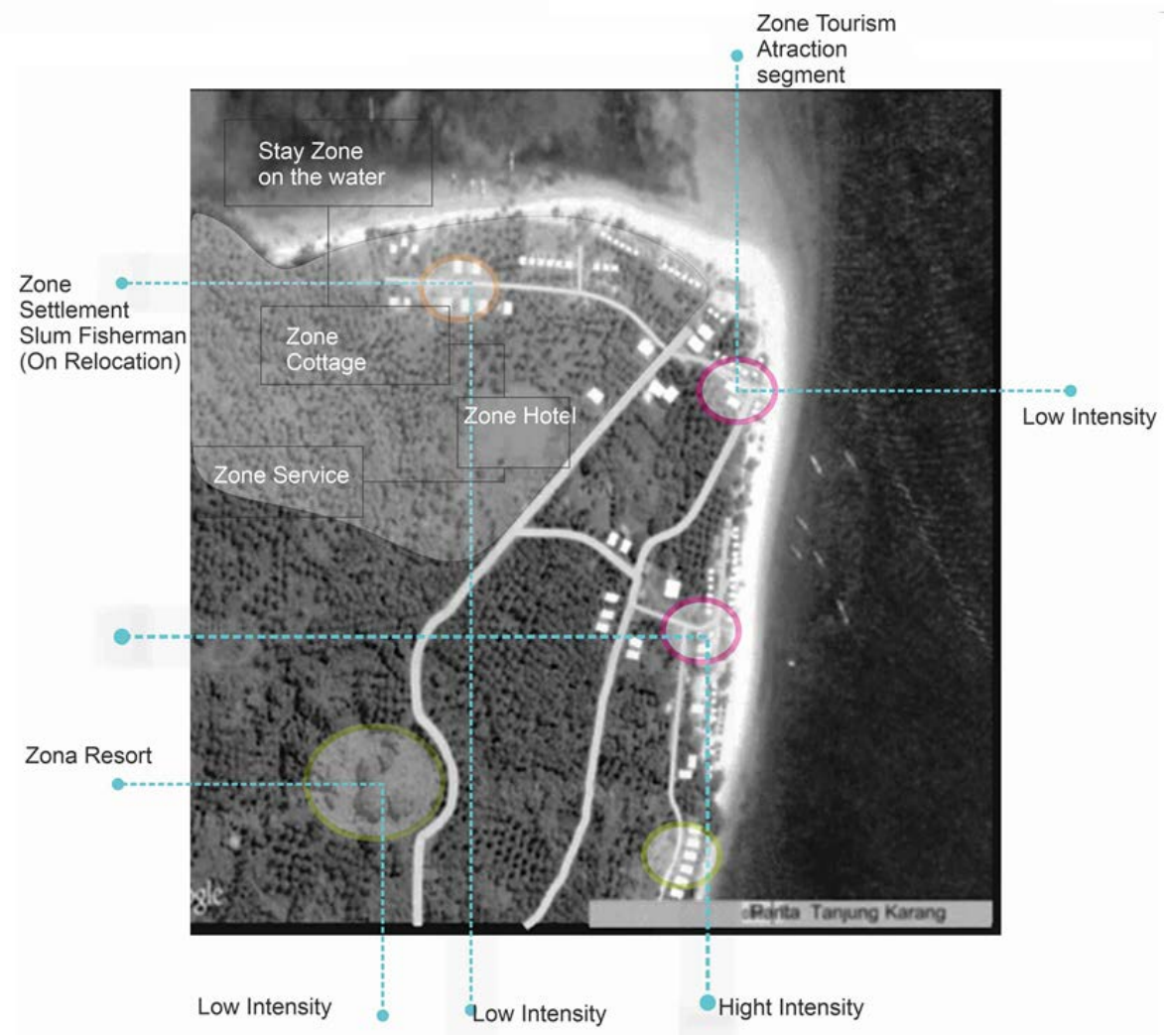


Figure 6. Zoning of the Tourism Beach of Tanjung Karang

Figure 7. Facility Relationship of Tanjung Karang Beach

The relationship of outdoor was underlined by the zoning and facility program. The inter-connected zoning layout was aimed to compact each mass of buildings. While, the constructed area was a hotel, adjoinedly with supporting facilities, such as fitness and spa, restaurant. Whereas, the unconstructed area was planned as resort areas, such as plaza, pool, and sports facilities for tourists to relax in creating a vibrant and attractive outdoor facility from (Figure 7).

3.2.2. Effects of Hills, the Sun, and Wind

The topography of the tourism object of Tanjung Karang beach had a medium contour, available for gardens and buildings. One of them was ‘pool’ due to freezing air at night. The Sun’s orientation was directed to the sunset, in case to obtain a sunset view for cottage dan floating villa. The east part cannot see the sunrise due to being obstructed by the hills and valleys of Palu. While the southside had higher intensity of the Sun’s light.

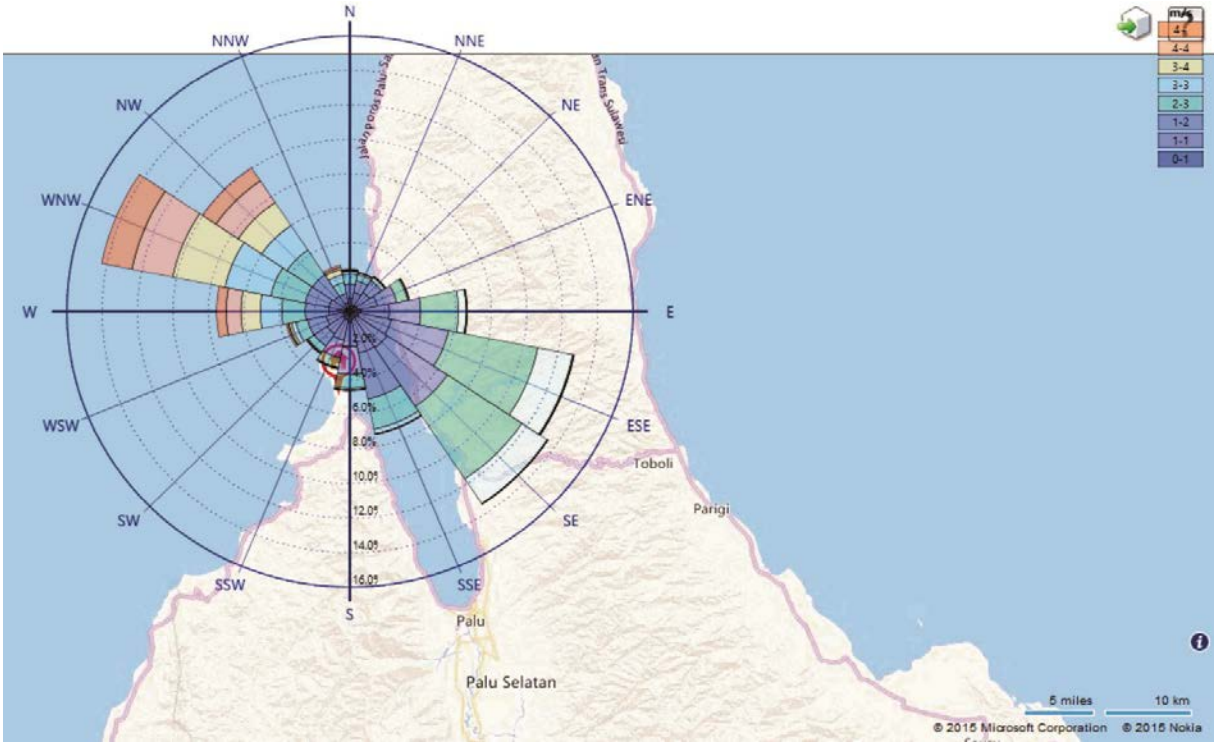


Figure 8. Site Analysis based on Wind Course

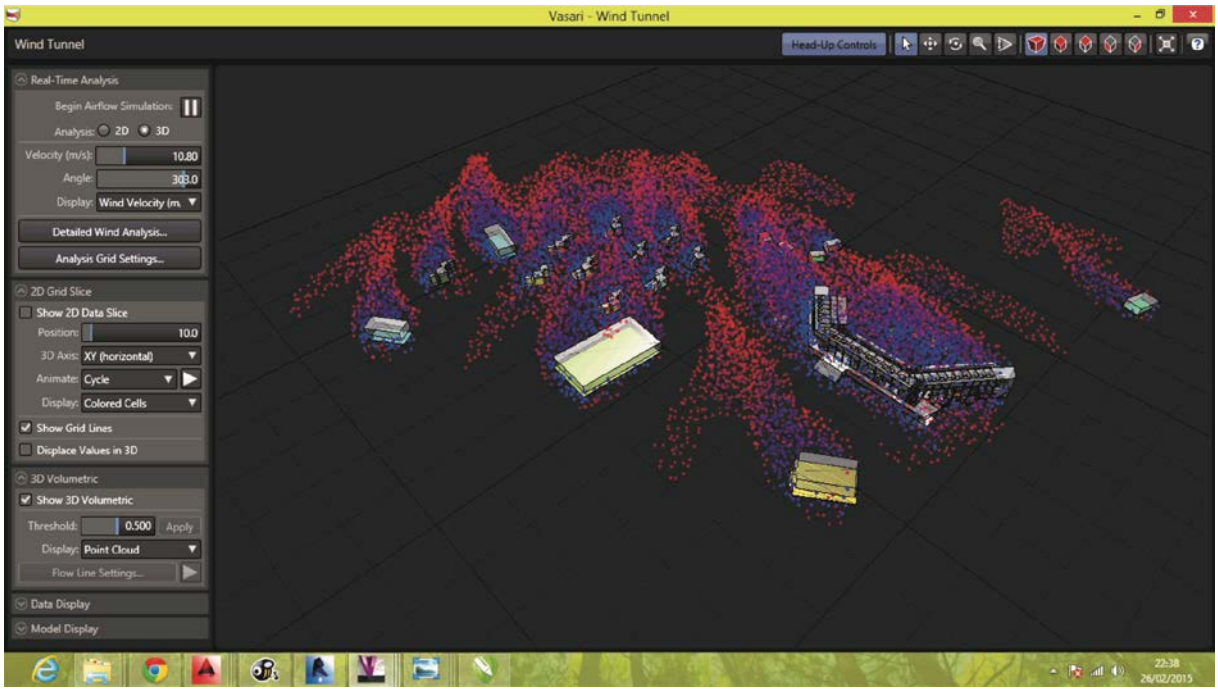
The most beneficial wind course was a linearly straight to wind direction, based on data as depicted in (Figure 8). Further, the wind speed was at the northwest, by more than 4 m/s. It could be analyzed from mass disposition, where it could enrich green plants as a filter to reduce dust and silence the noise. The wind course as referred was sea breeze, mainly in the coastal area.

3.2.2. Vegetation Impact

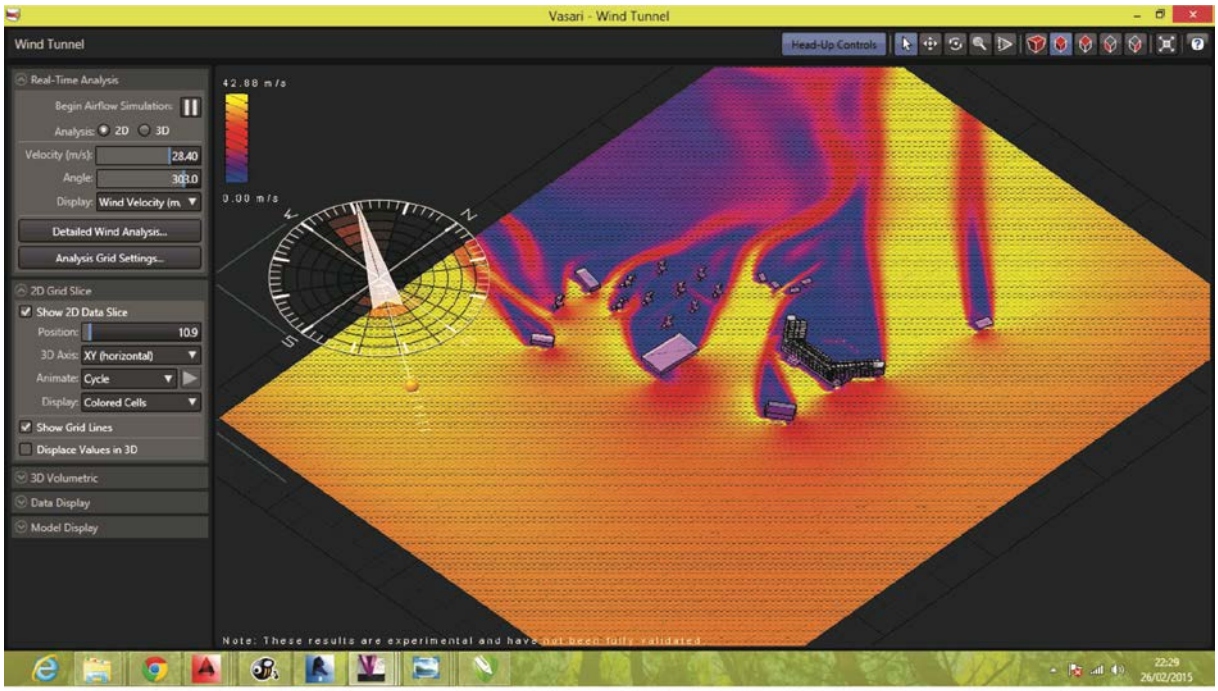
The tourism area of Tanjung Karang was surrounded by the sea breeze from the northern to eastern. However, by the absence of wind, resulting from macro scale in the weather phenomenon, the water surface would highly affect local air movement. It was because water (having specifically higher heat than the land's materials) was usually colder than the land at midday and warmer at night. Therefore, the usage of natural vegetation covering inclinningly stabilized temperature and reduced heat. Meanwhile, the artificial surface tended to increase heat. Particularly, plants are natural absorbers of heat, light, and sound. Additionally, trees must provide cover to the rooftop and walls, but they must prevent air circulation surrounding buildings. Thus, the design should be in line with coastal plants formation, producing the green lane in the tourism site. The constructing of the green lane was aimed to produce an integrated relationship between a parking lot and the green area, in the topography changes. It means that the tree's path was a building shelter. Hence, the selection and formation of plants must be in line with the coastal area. The type of plants, also, is adjusted by the types of altitude and distance that can affect visuals from the building's plan. Some species of beach plants planned as the design of green lane can be pandanus types, such as sea pandanus (*P. Tectorius*) and Wong pandanus (*Pandanus* sp.), and trees, comprising of *Keben* (*B. Asiatica*), Catapa (*T. Catapa*), sea hibiscus (*H. Tiliacerus*), sea pine tree (*C. Equisetifolia*), Coconut tree (*C. Nucifera*), mangrove, palm king, and varied decorative plants and fruits in line with the beach site.

1
2
3
4
5
6
Types of Plants
1.Sea waru (H. tiliacerus), Borogondolo (H. peltata), Nyamplung (C.inophylum)
2. Palm tree, Check, Sea Pandan. (P. tectorius)
3. Ketapang (T. catapa), Sea spruce, (C. quisetifolia)
4. Sea Spruce (C. equisetifolia), Coconut Tree (C.Nucifera)
6. Plam trees, Check, and Sea Pandan (P. tectorius), Pandan Wong (Pandanus sp.)

Figure 9. Plan of Green Lane in the Site



(a)



(b)

Figure 10. A. Wind Bias that can be utilized in building. B. Utilizing the wind in the mass building layout for the July-December period(Peak Season).

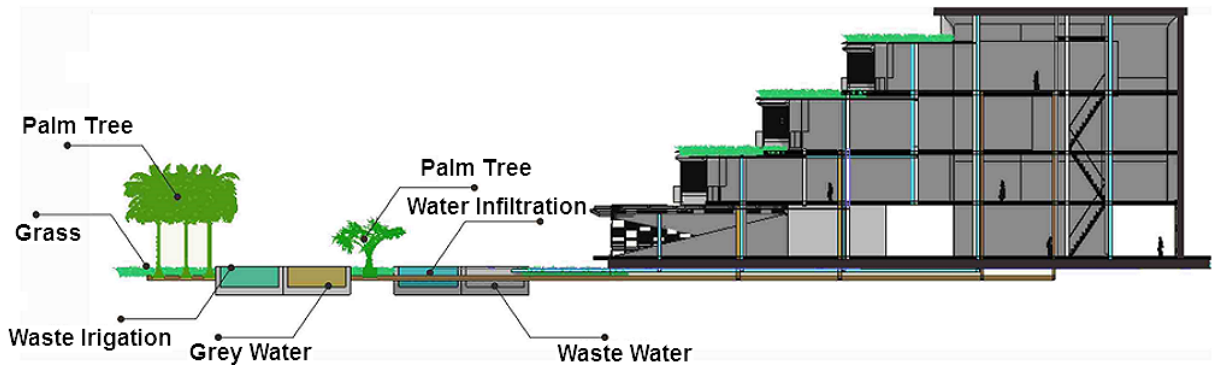


Figure 11. Detail of Wastewater Reservoir Slice

3.2.3. Spatial Impact of Building Mass

Based on the effects of wind orientation [9], the spatial/outdoor of the site development should be as wide as possible. To minimize environmental destruction, the size of the resort's site will enable it to have an unlimited position in the buildings. Generally, in a humid area, such as tropical regions, the coastal buildings must fully be affected by the wind. Thus, the analysis of the Wind Tunnel (Figure 10) was made to analyze the directly incoming wind to all sections of the building, in terms of ensuring free movement of the wind. Moreover, the buildings of hotel resorts should also be placed evenly to avoid and obstruct the sea breeze.

3.2.4. Wastewater Management

The consideration in the rainfall and wastewater management in the site is as follows. The waster necessity was used for facilities, such as hotel, hall, cottage, having higher needs. In the condition of slope land where the clean water wheel was lower, the distance required between the clean water wheel and the reservoir wheel was minimally 15 m (Figure 11). Then, the disguised basin reservoir was made like a fish pond, and the rainfall reservoir or lake was also made. It was aimed to contain clean water and wastewater, and a distributor to plants. [9].

Distribution from the Local Water Entity was directly used as clean water, and the wastewater was utilized for irrigation making. The reservoir was a pond disguised by bushes and grass. Additionally, after sterilization, the rainfall was reused before it was contained in a fish pond. Different from the cottage, a separated reservoir was made in each unit.

3.2.5. Mass Building Layout

According to the circulation pattern in the previous

analysis, the spatial design was adjusted with a dominant wind course, such as the sea breeze. Next, the existing cross-ventilation with different mass was done in the opening orientation in wider mass and limited by trees. Thus, it still had private nuance for tourists staying at the site. The main mass was a hotel prefaced by the hall facility, so it was planned for the main entrance; and, cottage and floating villa were placed behind the hotel because the main lobby of the hotel was aimed for reservation.

3.3. Elaboration of Hotel Resorts Design

According to the result of site analysis, the formation of the main mass was hotel resorts.

3.3.1. Transformation of Hotel Resort Design

The building of hotel resorts was based on Kalili's architecture, having been culturally rooted, adapted, and evolved since a long time ago. Thus, the design was a combination and mixing between traditional or local and global architecture. The strategy of form and space was able to perform since architecture is a restoration of form and space, function, and meaning. Kalili's architecture became the basic form in the form transformation of the composition from Souraja's traditional architecture. It can be seen from the function of Kalili's traditional building, having spiritual and religious functions by combining three elements of life.

Subsequently, the basic philosophy of the building's forms started from three elements, such as the basement (human), middle (nature), and the rooftop (the creator). The theory of Transformation [10] argued that types of architectural forms comprise of building style, having the rooftop, wall, terrace (*Gandaria*), and ornament design applied from ideas in the hotel resort design. The following is the transformation process of Souraja into modern architecture in the designing of hotel resorts (see Figure 12).

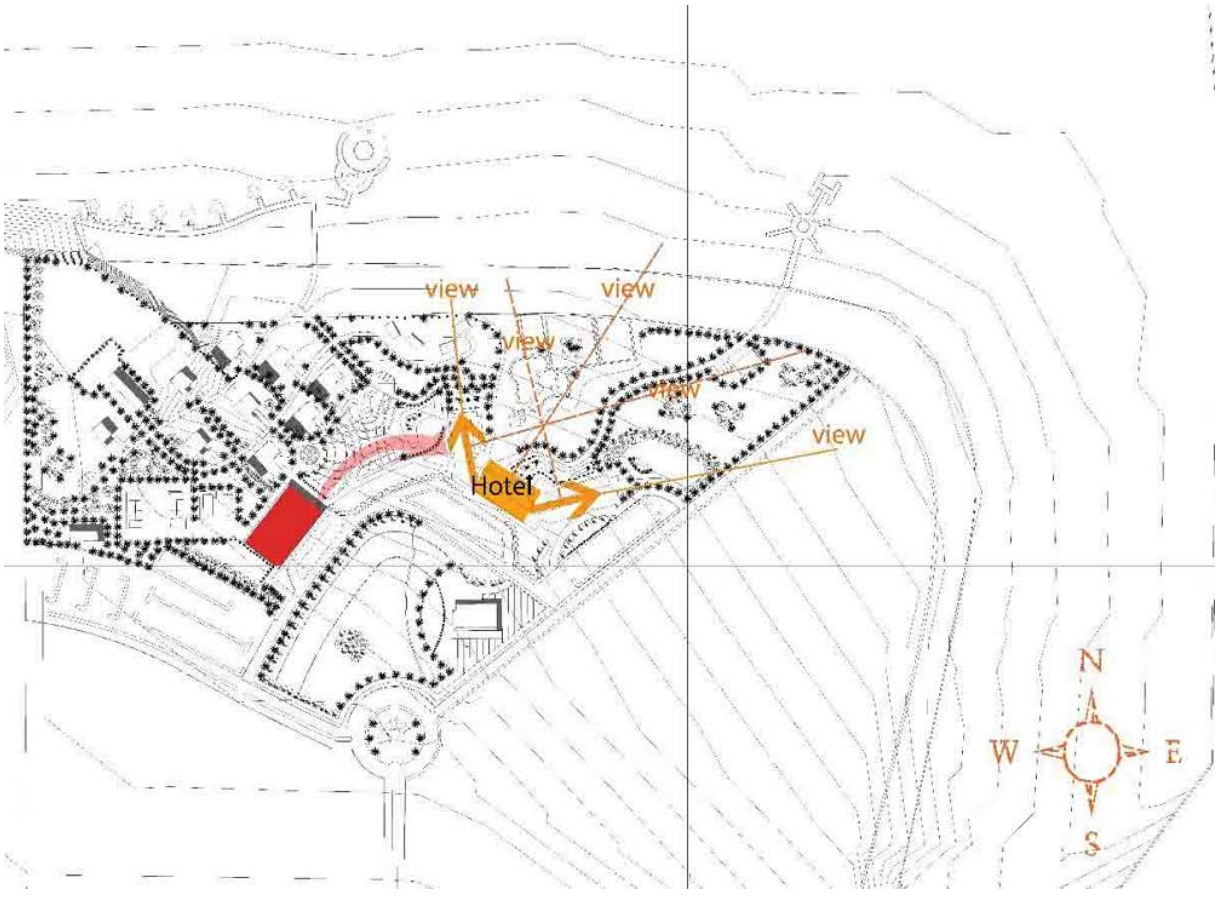


Figure 12. Massa hotel in the square form, adjusting the result of site analysis

3.3.2. Energy Utilization in Hotel Resorts

According to the data sources of massive buildings from the analysis of the Autodesk energy, Green Building Studio.

Function: Hotel by the basement area: 2,734 m² and a total of 4 non-typical floors. It means that the total of areas per loor was 10,937 m²

(1) Water and electricity factors of the indoor: the total of users was 705 people,

(2) Annual Electricity Usage: The electricity usage was based on activity performed, such as a hotel. The consideration of a total of usages and a total of electricity used was 1,998,131 kWh/754 MJ / m² / year, with various uses, such as data analyzed from GBS (Figure 13)

(3) Solar energy and its usage The average temperature at the outdoor was maximally 33°C and minimally 23°C (Weather Data of the Regency of Donggala / City of Palu). The utilization was local and heat-proof materials in the Sun's mass simulation with building mass, starting at 10.00 on December-January (Peak season) or holiday season. During this period, the south area had higher heat intensity (Figure 14).

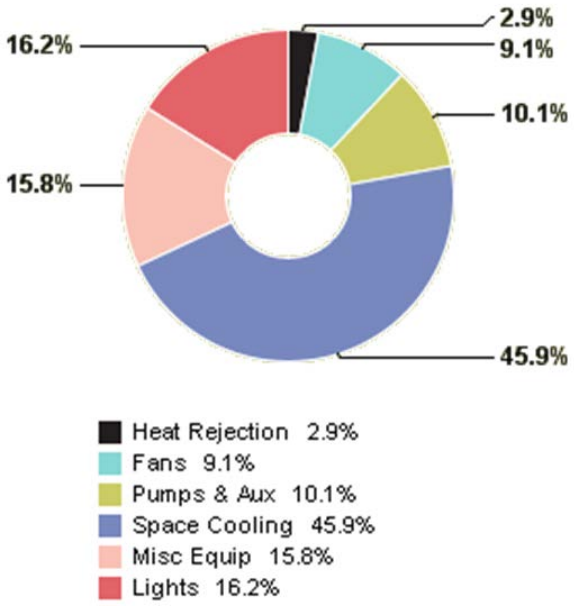


Figure 13. Graphic of Electricity Utilization based on Necessity

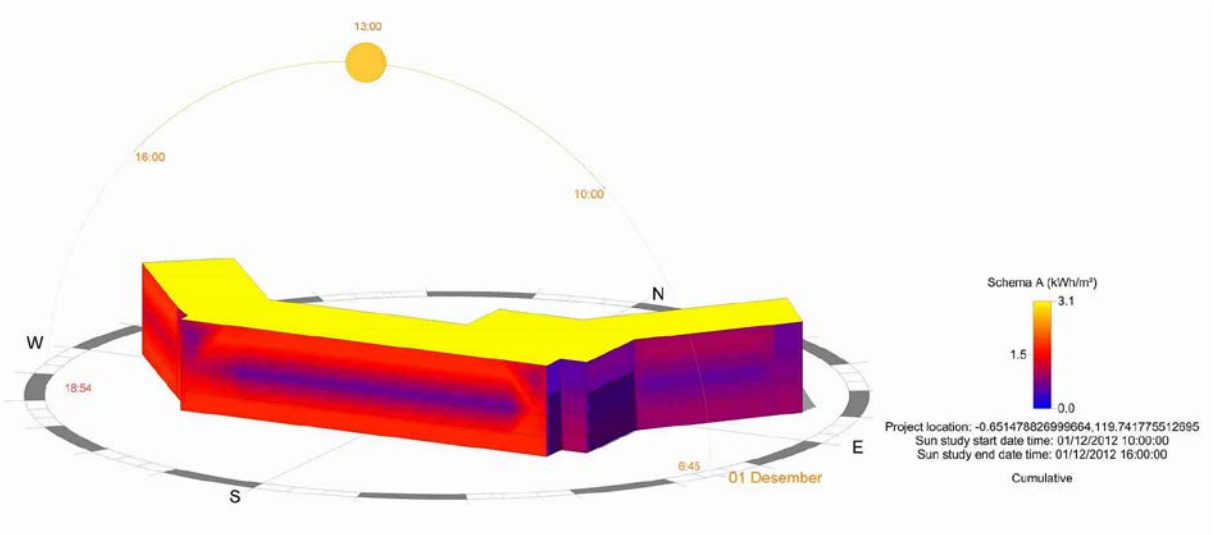


Figure 14. Simulation of massive buildings with the Sun at 10.00 on December-January (Peak season)

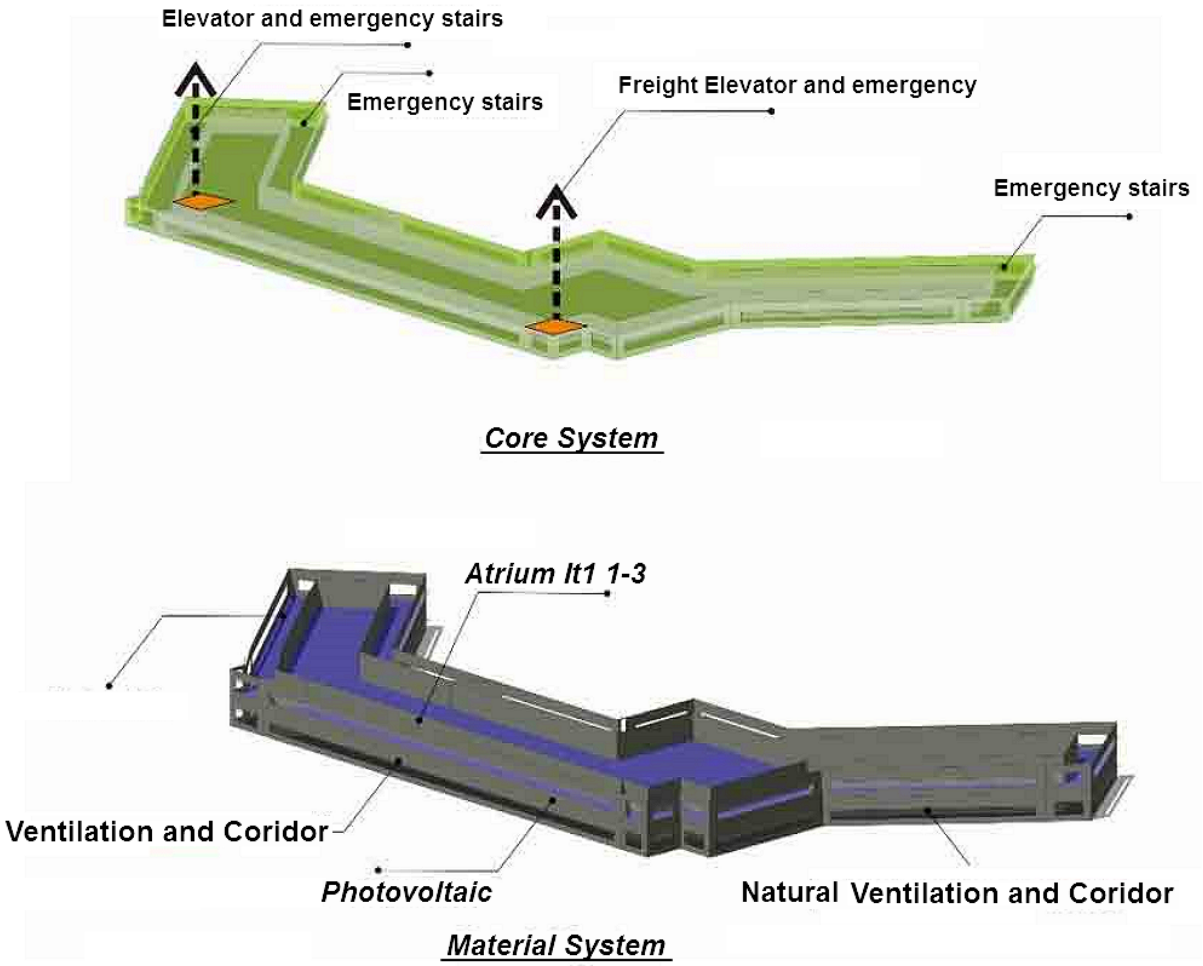


Figure 15. Core and Material System in Hotel Resorts

The following figure depicts a part affected directly by the Sun's light. Then, the buildings had natural ventilation, cross-ventilation, and the use of local materials, such as coconut poles, and were insulated by traditional rooftops. It was used to follow the context of local architecture and existence factors in the tropical climate of the coastal areas (Figure 15). In addition, the utilization of Solar's panel, or photovoltaic, was installed on the south side to be electrical power.

In Indonesia, the excess of the Sun's light should be used maximally. However, due to its position as a tropical country, the Sun's light is accompanied by heat, so the design of hotel resorts used skylight. This design was utilized for the direct Sun's light in the morning, starting at 08.00, where it was better for occupants and corridors of the hotel resorts, until 10.00 a.m (Figure 16 and Figure 17). Further, it is because the site is located in the east, where the Sun rises.

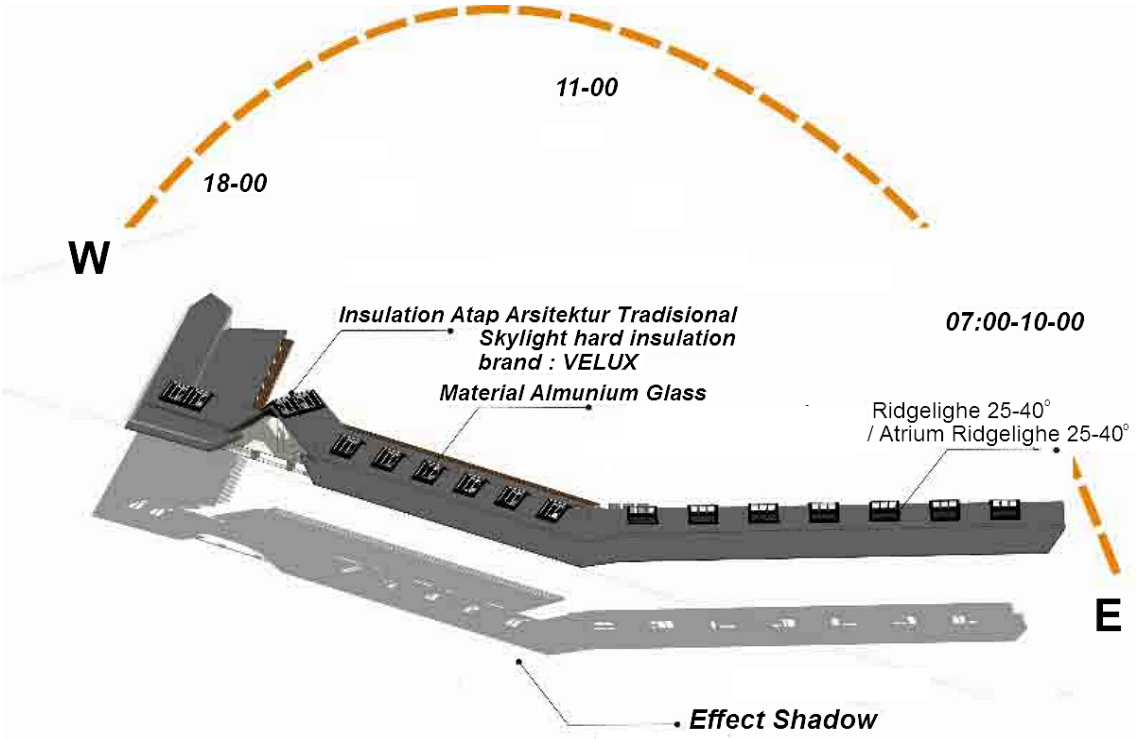
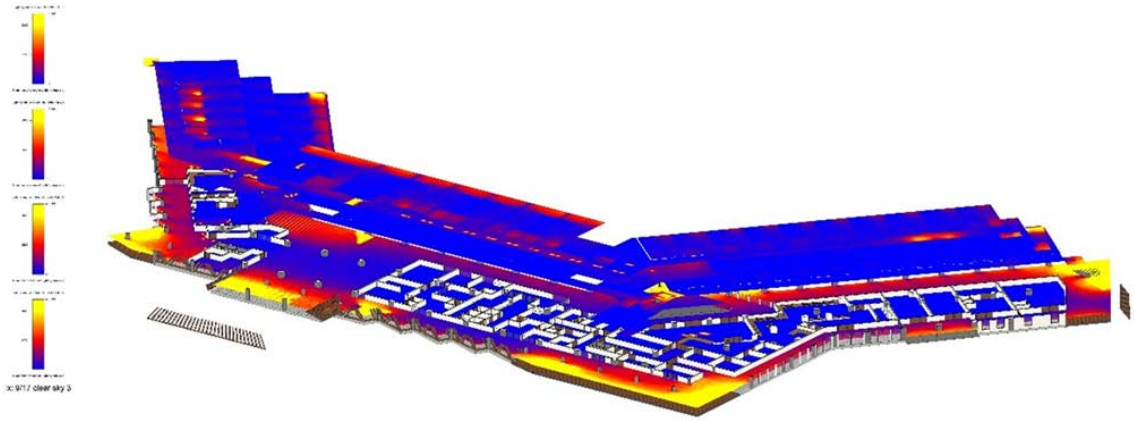
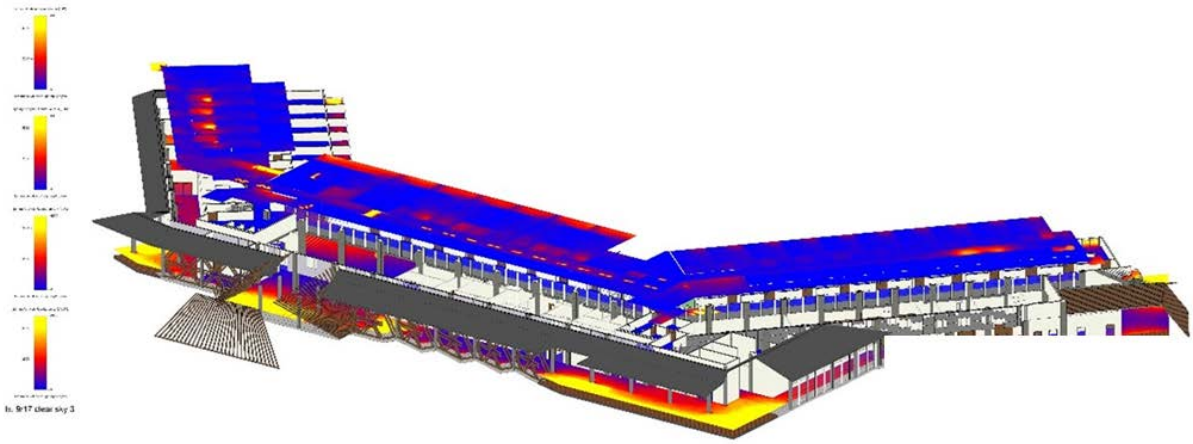


Figure 16. Daylight potency to support natural lighting from the rooftop of the building in the usage of Skylight



Second Floor



Third Floor

Figure 17. Result of solar simulation with the usage of Skylight, using Software Revit solar simulation

(4) Simulation of natural light utilization per floor in the buildings of hotel resorts

This simulation explains that the material also determined temperature due to the direct Sun's light. According to the figure above, there was a part of uncovered buildings by a shelter, such as the entrance's terrace. Then, the best way was the use of a canopy or sunscreen. The facade of the buildings also used solar's energy for the natural lighting, by a means of the random facade. In detail, the simulation was used for the period of June-September (Table 2 and Table 3).

(5) Photovoltaic system utilization in hotel resorts

Table 2. Photovoltaic potential

Panel Type	Installed Panel Cost	Applied Electric Cost	Max Pacback Period
Poly Crystaline 12,3% Efficient	$8.00 (Perwatt) $984.63 (per m^2)	$0.06 (per kWh)	50 per Surface, in Years

Table 3. Potential Utilization of Photovoltaic based on each of Revit 3D, green building studio

Annual energy-saving:	705,820 kWh
Total Price of Panel Installation:	$3,433,691
Nominal of capacity value:	429 kW
Total of Panel Areas:	3,487 m²
Maximal returns period:	48 years @ $0.06 / kWh
Type of Poly Crystalline panel by 12.3 % of efficiency	

The calculation of the need for solar panel/Photovoltaic

(1) Nominal of panel capacity value: 429 kW/year, converted 429000 watts: 365 days = 1175 watts/day.
(2) Hour usage (18.00-04.00) = 10 hours, 1175 x 10 hours = 11750 watts
(3) Inventor and controller (20%) = 11750+(11750 x 20%) = 11750 + 2350 = 14100 watts
(4) Battery voltage by 55 ah 12 V with 22 battery = 14520 watts, 200 watts excess, considered as normal due to the calculation of battery was not precisely correct.
(5) By 14100 watts, obtaining the total of panels as required. If using the standard size of the panel, the calculation was 80 Wp x (5 hours/average effectiveness of the Sun's light in the tropical area, such as Indonesia) = 400 watts = 14100:400 = 35,25 or 35 poly-typed solar panel.

The hotel resorts were oriented to the south, existing in the main entrance as the drop off to the main lobby. This building was also positioned in the Sun's line, as seen in the map being the main point in the improvement of the existing micro-climate quality.

(6) Water usage in Hotel Resorts

Table 4. Water utilization at outdoor and indoor

Areas	Water usage	Cost
Total:	39,868,857L/Year	$61,344/Year
Indoor:	39,868,857L/Year	$61,344/Year
Outdoor:	1,806,228L/Year	$469/Year
Net Utility:	39,223,386L/Year	$61,166/Year

'Source: AWWA Research Foundation 2000 Residential/Commercial and Final Institution of Water Utilization, (Table 4).

(7) Water factor at outdoor

Irrigation area* (m^2): 2000 m^2. Sprinkler watering time: Pond: 11,791,085 gallon/year. Annual water price unit: 0.69 $ / m^3 (Source of America) Daily water usage: 25 days/liters

*Irrigation area is a placeholder. Site data of the non-inserted building model.

Figure 18. Simulation Result of Photovoltaic and Skylight Utilization

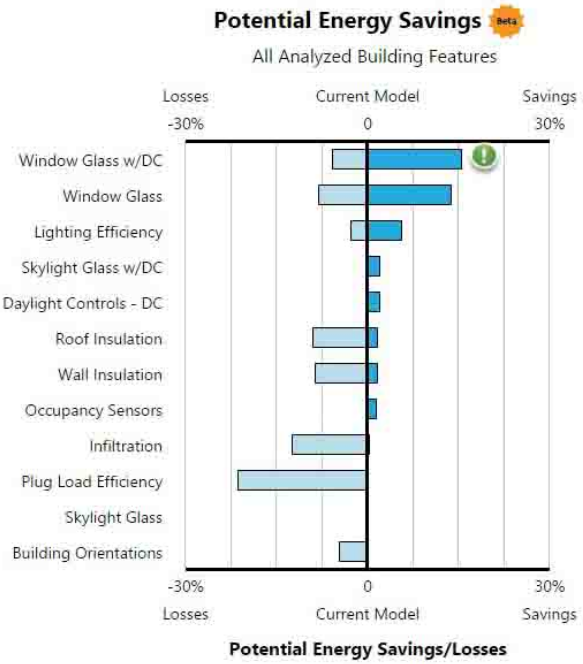


Figure 19. Potential Energy Savings/Losses

3.3.3. Result of Energy Utilization in Hotel Resorts

Based on the data above, it can be described that the simulation result, previously having been analyzed, had equally proportional, in terms of energy disposing and depositing.

(Figure 19). Based on the data above, it can be described that the simulation result, previously having been analyzed, had equally proportional, in terms of energy disposing and depositing.

The main source of water in the buildings was derived from the Local Water Entity. The water was contained in the clean water reservoir before being distributed. Also, the basin reservoir made water available for a certain time, in case there was a water shortage. The water-saving also could be done by the use of the closet, using ½ tank of flushing button and fully flushing. It was aimed to select a suitable flushing volume. Recently, the closet has been equipped with a water-saving tank.

In the utilization of a water pump to obtain clean water, the existence of a water reservoir placed in the building could save electrical energy due to the pump was not always on as each faucet opened. Then, the basin reservoir could be placed underneath (up-feed system) (Figure 21).

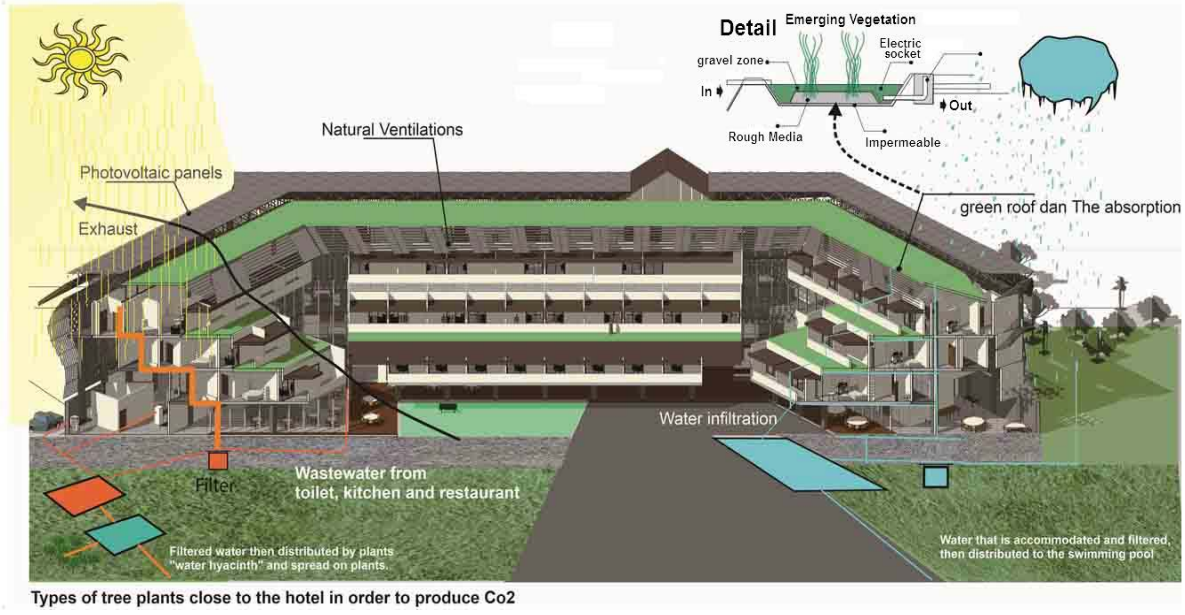


Figure 20. Simulation Process of Energy Utilization in Hotel Resorts

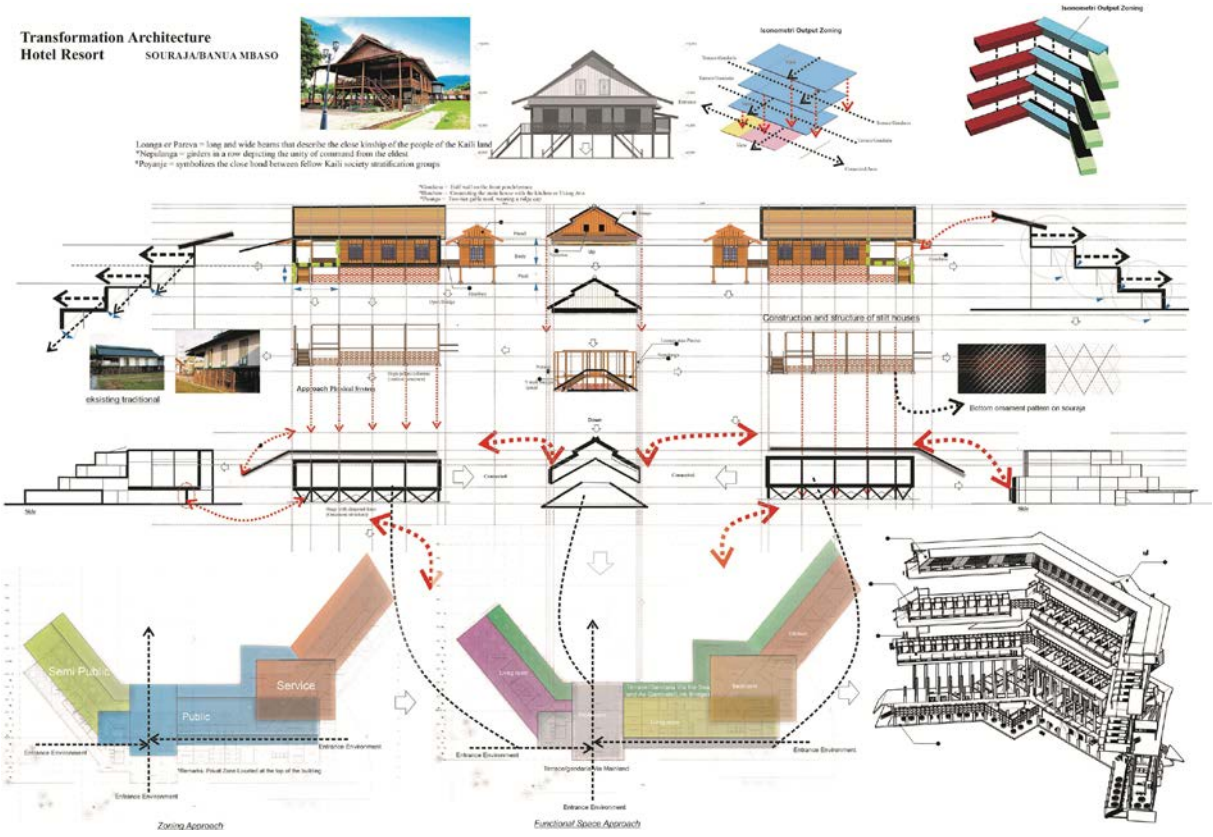


Figure 21. Architecture Transformation of Hotel Resort

Table 5. Review of buildings and deposit efficiency

Actions			Depositing		
Annual rainfall in the City of Palu and Regency of Donggala (mm)		**Catchment Area/Rooftop (m^2)**	**Type of Surfaces**	**Liter per year**	**Annual costs saving**
Rain-water reservoir	80 mm averagely	2734 m^2	Soil/gravel	174,976	121
Genuine vegetation of Landscape				904,489	624
Waste reclamation				226,122	364
Source of drinking-water sites	Result	50 liters/day		18,250	13
Total of Net-Zero Supplies				1,323,837	$1,121

*Source: 2000 Uniform Plumbing Code of the IAPMO, Tables 4-1 and 4-3, software: based on Revit massing 3D, green building studio.

Table 6. Net Zero Action and Net Zero Depositing

Review of Buildings				Deposit efficiency				
Furnitures	**Total**	**Male**	**Female**	**Employees**	**Efficiency**	**Indoor utilization percentage (%)**	**Gallon per year**	**Annual costs-saving**
Toilet	104	90		14	Low circulation	9.3	4,825,565	7,769
Urinals	7	7		0	Low circulation	1.6	844,844	1,360
Wash basin	104	35	55	14	Low circulation	5.7	2,953,400	4,755
Showers	74	38	38		Low circulation	6	3,112,178	5,011
Washing machine	10				Standard	0	0	0
Dishwasher	10				Efficient	0.1	55,099	89
AC tower	1				Standard	0	0	0
Total of Deposit Efficiency						22.8%	11,791,085	$18,984

* Source: National Climax Data Center, # CLIM8, software: based on Revit massing 3D, green building studio

4. Conclusion

The architectural biomimetic approach is focused on utilizing the quality of surroundings in a sustainable development design. Thus, it can be articulated that the biomimetic approach is the implementation of action and principle in a managed environment, related to architecture, climate, technology, and biology, mimetically, and relevant transformation. In its implementation, the principle and action of architectural biomimetic design are demanded to not only copy the form of creatures or nature directly, but also present an environmentally friendly design to surroundings, or it should be in harmony with the surroundings. In short, this approach proposes an adaptable building design, like creatures.

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